Making Value-Added Products from Combustion Fly Ash by Triboelectrostatic Processing

John M. Stencel, Jim Neathery and T.-X. Li
stencel@caer.uky.edu; (606) 257-0250; FAX (606) 257-0318
Center for Applied Energy Research, University of Kentucky
2540 Research Park Drive, Lexington, KY 40511

Summary

Triboelectrostatic beneficiation of combustion fly ash at our laboratory has focused on establishing the data and techniques necessary for pneumatic transport processing. During the development of our proof-of-concept (POC) platform, which is used at feedrates up to 500 lb/hr, the throughput of the separator was increased to approximately 4000 $lb \cdot f^{-2}$. Its design is based on fundamental experimentation performed at the Center for Applied Energy Research (CAER) over a six year period. Although the primary direction of our pneumatic transport, triboelectric processing continues to be in the area of removing unburned carbon from ash, recent work has examined the potential of our processing technique to selectively extract components other than carbon from ash. If selective extraction was possible, and if the processing was relatively inexpensive or the extracted component had market values greater than the fly ash itself, then triboelectrostatic processing could add to the revenue base of companies which handle or sell ash. Additionally, it could help to increase the utilization of combustion ash, thereby promoting ash as a more useful and valuable resource.

Fly ash is a complex physical mixture of very small particles. The value of some of the components, for example - cenospheres, is greater than that of the unburned carbon or purified fly ash. Although beneficiation techniques based on flotation, density and magnetics have been studied for years in efforts to extract fly ash components, no previous work has been found which has attempted to apply pneumatic transport, triboelectrostatic beneficiation as a way to selectively extract distinct components. Because it beneficiates on the basis of the particulate's surface electronic properties, triboelectrostatics may be expected to extract components from fly ash that are different than those extracted by other beneficiation techniques.

Two ashes had been collected at utilities, and were the product of combusting bituminous coal. Their LOI contents were between 5-15%. They were subjected to carbon burn-out in a laboratory furnace at 750^{o}C for 16 hours. After burn-out, the samples were beneficiated in our laboratory separator, and then examined by using optical microscopy, scanning electron microscopy, x-ray diffraction and size/density techniques.

It was found that pneumatic transport, triboelectrostatic beneficiation can separate particles that have varying degrees of color, size, crystallinity and density. Optimization experiments are not yet complete. Presently, however, the color selectivity seems to be associated with color centers within and on ash particles, some of which are Fe-based. The selectivity to crystallinity is probably associated with a higher concentration of surface imperfections or impurities on the amorphous particles than on the

crystalline particles. These imperfections may be expected to have electron donor/acceptor properties that are different than the donor/acceptor properties of highly ordered, crystalline surfaces. If size segregation for the ~2-10 Fm particles could be performed in conjunction with amorphous particle extraction, the product may, in part, be used as a substitute for fumed silica. In general, then, the presentation will discuss the unique particulate extraction potential of pneumatic transport, triboelectrostatic beneficiation.